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Published: 25/07/2018

Document Version
Accepted manuscript including changes made at the peer-review stage

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Download date: 07. Dec. 2018
A sequentially coupled shape and topology optimization method

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Coupled method (2D)

- Minimizing the compliance \( c \) of a structure with volume \( V \) constraint, e.g. as shown in Fig. 1.
  - Shape optimization (SO).
  - Topology optimization (TO).

Research gap

- A sequentially coupled shape and topology optimization method
  - SO generally cannot introduce a new topology.
  - Solutions of TO are bounded by the chosen design domain.

Maximizing the compliance (CTSO) and finding new topology (SO) iteratively.

Modeling

- Optimal placement of a given amount of material in an optimal design domain, implemented to solve 2D, 2.5D and 3D design problems.

Scope

- Structural design problem
- Modeling
- Solution

Motivation

- Coupled optimization model
- Sequencing solution strategy

Conclusion

- Conclusions and future work
- Convergence history
- The final geometry of the beam can be obtained by interpolating the data of cross sections along the length direction.

Application (3D & 2.5D)

- 3D design problem
- 2.5D design problem

Fig. 2: Slender elastic cantilever beam with uniform rectangular cross section.

Fig. 1: Classic cantilever beam with varied height \( \mathcal{M} \) (initial \( \mathcal{H} = \mathcal{M} \) if \( \mathcal{M} = \mathcal{M} \)).

Initial design

- \( c = 2.488 \) N\( \cdot \)m

TO model

- \( c = 0.751 \) N\( \cdot \)m

SO model

- \( c = 0.371 \) N\( \cdot \)m

2-node beam FE.

CTSO

- \( c = 0.160 \) N\( \cdot \)m

TO model

- \( c = 0.215 \) N\( \cdot \)m

Initial design

- \( c = 3.836 \) N\( \cdot \)m

TO model

- \( c = 1.586 \) N\( \cdot \)m

SO model

- \( c = 0.278 \) N\( \cdot \)m

CTSO

- \( c = 4.508 \) N\( \cdot \)m

TO model

- \( c = 1.665 \) N\( \cdot \)m

SO model

- \( c = 1.984 \) N\( \cdot \)m

to

SO

- \( \rho \geq 0.75 \)

CTSO

- \( \rho \geq 0.75 \)

TO

- \( \rho \geq 0.75 \)

SO

- \( \rho \geq 0.75 \)

CTSO

- \( \rho \geq 0.75 \)

TO

- \( \rho \geq 0.75 \)